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भारतीय मानक

विद्युत चुम्बकीय संगतता (ई एम सी)

भाग 4 परीक्षण और मापन तकनीकें

अनुभाग 16 0 हट्र्ज से 150 किलो हट्र्ज तक के आवृति रेंज में सामान्य तरीके से व्यवधानों को उत्पन्न करने हेतु प्रतिरक्षा परीक्षण

(पहला पुनरीक्षण)

Indian Standard

ELECTROMAGNETIC COMPATIBILITY (EMC)

PART 4 TESTING AND MEASUREMENT TECHNIQUES

Section 16 Test for Immunity to Conducted, Common Mode Disturbances in the Frequency Range 0 Hz to 150 kHz

(First Revision)

ICS 33.100.20

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NEW DELHI 110002

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Electromagnetic Compatibility Sectional Committee, LITD 09

NATIONAL FOREWORD

This Indian Standard (Part 4/Sec 16) (First Revision) which is identical with IEC 61000-4-16 : 2002 'Electromagnetic compatibility (EMC) — Part 4-16: Testing and measurement techniques — Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electromagnetic Compatibility Sectional Committee and approval of the Electronics and Information Technology Division Council.

This standard was originally published in 2001 and was identical to IEC 61000-4-8 : 1998. Amendment No. 1 was issued to IEC 61000-4-8 : 1998 in 2001 which was incorporated into text in 2002. The standard thus was revised to align it with this latest edition of IEC Publication which incorporates the text of amendment also.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60050-161 : 1990 International Electrotechnical Vocabulary (IEV) — Chapter 161: Electromagnetic compatibility	IS 1885 (Part 85) : 2003 Electrotechnical vocabulary: Part 85 Electromagnetic compatibility	Identical
IEC 60068-1:1988 Environmental testing — Part 1: General and guidance	IS 9000 (Part 1) : 1988 Basic environmental testing procedures for electronic and electrical items: Part 1 General (*first revision*)	Technically Equivalent

Only the English language text of the International Standard has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in the IEC Publication.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

IS 14700 (Part 4/Sec 16) : 2008
IEC 61000-4-16 : 2002

Indian Standard

ELECTROMAGNETIC COMPATIBILITY (EMC)

PART 4 TESTING AND MEASUREMENT TECHNIQUES

Section 16 Test for Immunity to Conducted, Common Mode Disturbances in the Frequency Range 0 Hz to 150 kHz

(First Revision)

1 Scope

This part of IEC 61000 relates to the immunity requirements and test methods for electrical and electronic equipment to conducted, common mode disturbances in the range d.c. to 150 kHz.

The object of this standard is to establish a common and reproducible basis for testing electrical and electronic equipment with the application of common mode disturbances to power supply, control, signal and communication ports.

This standard defines

- test voltage and current waveform;
- range of test levels;
- test equipment;
- test set-up;
- test procedures.

For some types of ports, for example ports intended to be used with highly balanced lines, additional test provisions may be established by product committee specifications.

The test is intended to demonstrate the immunity of electrical and electronic equipment when subjected to conducted, common mode disturbances such as those originating from power line currents and return leakage currents in the earthing/grounding system.

The disturbances produced by 400 Hz mains systems are not included in the scope of this standard.

Actual interference due to these disturbance phenomena is relatively rare, except in industrial plants. Product Committees should therefore consider whether there is a justification for applying this standard in their Product/Product Family standards (see also clause 3).

This test is not relevant for equipment ports intended to be connected to short cables, having a length less than 20 m or less.

The immunity to harmonics and interharmonics, including mains signalling, on a.c. power ports (in differential mode) is not included in the scope of this standard and is covered by IEC 61000-4-13.

The immunity to conducted disturbances generated by intentional radio-frequency transmitters is not included in the scope of this standard and is covered by IEC 61000-4-6.

Some ITU-T Recommendations, e.g. K17, K20 and K21, establish similar methods for testing the resistibility of equipment; however, they are dedicated to telecommunication ports and deal with power induction at frequency of the a.c. mains or electric railways.

Product Committees are advised to consider the Recommendations above, as far as applicable, in preparing their product standards.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(161):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*

3 General

The conducted, common mode disturbances in the frequency range d.c. to 150 kHz may influence the reliable operation of equipment and systems installed in residential areas, industrial areas and electrical plants.

Only those ports of an EUT which are likely to be subjected to the disturbances dealt with by this standard shall be considered for the application of its requirements.

The disturbances are typically generated by

- the power distribution system, with its fundamental frequency, significant harmonics and interharmonics;
- power electronic equipment (e.g. power convertors), which may inject disturbances into the ground conductors and earthing system (through stray capacitance or filters), or generate disturbances in signal and control lines by induction.

At the mains frequency, and harmonics of the mains frequency, the disturbances are usually generated by the power distribution system (fault and leakage currents in the ground and earthing systems).

At frequencies above the range of harmonics of the mains frequency (up to 150 kHz) the disturbances are usually generated by power electronic equipment, which is often found in industrial and electrical plants.

The coupling of the source of disturbances with the power supply, signal, control and communication cables, transfer these disturbances to the ports of the equipment under test.

Because the coupling mechanisms defined above cannot be completely eliminated, it is necessary for equipment to have adequate immunity to the disturbances.

Depending on the type of installation, the disturbances may be classified as follows:

a) voltage/current at power frequency: d.c., $16^{2/3}$ Hz, 50 Hz and 60 Hz;

b) voltage/current in the frequency range 15 Hz-150 kHz (including the harmonics of the mains frequency).

This standard defines the test procedures for both the categories of disturbance defined above. The applicability of the tests should be defined in the product standard.

Annex A contains more information on the phenomena.

4 Definitions

For the purpose of this part of IEC 61000, the following definitions are used and apply to the restricted field of conducted, common mode disturbances in the range d.c. to 150 kHz (not all of these definitions are included in IEC 60050-161).

4.1
EUT
equipment under test

4.2
auxiliary equipment (AE)
equipment that is necessary for setting up all functions and assessing the correct performance (operation) of the EUT during the test

4.3
port
particular interface of the specified equipment with the external electromagnetic environment (see figure 1)

4.4
coupling
interaction between circuits, transferring energy from one circuit to another

4.5
coupling network
electrical circuit for the purpose of transferring energy from one circuit to another

4.6
decoupling network
electrical circuit for the purpose of preventing test voltage applied to the equipment under test from affecting other devices, equipment or systems which are not under test

4.7
immunity (to a disturbance)
ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance [IEV 161-01-20]

5 Test levels

The preferred range of test levels, applicable to equipment ports as a function of the different types and sources of disturbances, is given in 5.1 and 5.2.

The levels are given for the tests at the mains frequency (d.c., $16^{2/3}$ Hz, 50 Hz and 60 Hz) and in the frequency range 15 Hz-150 kHz.

The applicability of each test shall be defined in the product standard.

The test voltage shall be applied in common mode to power supply, control, signal and communication ports (the differential mode voltage is dependent on the circuit unbalance).

A guide for the selection of the test levels is given in annex B.

5.1 Test levels at mains frequency

Tables 1 and 2 define the preferred test levels.

The levels apply to test voltage at d.c. and at the mains frequencies of $16^{2/3}$ Hz, 50 Hz and 60 Hz.

Table 1 – Levels for continuous disturbance

Level	Open circuit test voltage V (r.m.s.)
1	1
2	3
3	10
4	30
x	Special

NOTE x is an open level. This level may be defined in the product standard.

Table 2 – Levels for short duration disturbance

Level	Open circuit test voltage V (r.m.s.)
1	10
2	30
3	100
4	300
x	Special

NOTE x is an open level. This level may be defined in the product standard.

For short duration disturbances, the normal duration for each applied disturbance is 1 s; however, product standards may specify different durations for specific applications.

The test shall be carried out at one or more of the following frequencies: d.c., $16^{2/3}$ Hz, 50 Hz or 60 Hz, according to the relevant mains frequency in the equipment location (see annex A); the test at $16^{2/3}$ Hz is therefore only applicable where the equipment is intended to be used in the proximity of railway systems at this frequency.

The test level shall not exceed the test voltage defined in the product standard.

Information on the proposed test levels is given in annex B.

5.2 Test levels in the frequency range 15 Hz-150 kHz

Table 3 defines the preferred test levels.

Table 3 – Test levels in the frequency range 15 Hz-150 kHz

Level	Profile of the test voltage (open circuit) V (r.m.s.)			
	15 Hz-150 Hz	150 Hz-1,5 kHz	1,5 kHz-15 kHz	15 kHz-150 kHz
1	1 – 0,1	0,1	0,1 – 1	1
2	3 – 0,3	0,3	0,3 – 3	3
3	10 – 1	1	1 – 10	10
4	30 – 3	3	3 – 30	30
x	x	x	x	x
NOTE x is an open level. This level can be given in the product specification				

The profile of the test voltage in relation to frequency (see annex B for information) is as follows:

- starting from the frequency 15 Hz, the level decreases up to 150 Hz at 20 dB/decade;
- the level is constant from 150 Hz to 1,5 kHz;
- the level increases from 1,5 kHz to 15 kHz at 20 dB/decade;
- the level is constant from 15 kHz to 150 kHz.

The profile of the test voltage is represented in figure 2.

No test level is defined below 15 Hz, excluding d.c., as tests in this frequency range are not considered to be relevant.

6 Test equipment

6.1 Test generators

The features of the test generators for each specific test are given in 6.1.1, 6.1.2 and 6.1.3.

The generators shall have provisions to prevent the emission of disturbances which, if injected in the power supply network, may influence the test results.

Information on the impedance of the test generators is given in annex A.

6.1.1 Characteristics and performance of the generator for d.c. tests

The test generator typically consists of a d.c. power supply unit with variable output voltage and a time controlled switch for the short duration test.

Generator for continuous disturbance

– waveform:	direct current, ripple less than 5 %;
– open circuit output voltage range:	1 V (–10 %) to 30 V (+10 %);
– impedance:	50 Ω (±10 %);

Generator for short duration disturbance

- waveform: direct current, ripple less than 5 %;
- open circuit output voltage range: 10 V (–10 %) to 300 V (+10 %);
- impedance: 50 Ω (±10 %);
- rise and fall time of the output voltage at on/off switching: between 1 to 5 µs.

The schematic in principle of the test generator is given in figure 3.

6.1.2 Characteristics and performance of the generator for tests at mains frequency: $16^{2/3}$ Hz, 50 Hz and 60 Hz

The test generator typically consists of a variable transformer (connected to the mains distribution network), an isolation transformer and a time controlled switch for the short duration test; the switch shall be synchronized at 0° of the mains voltage waveform.

Generator for continuous disturbance

- waveform: sinusoidal, total harmonic distortion less than 10 %;
- open circuit output voltage range (r.m.s.): 1 V (–10 %) to 30 V (+10 %);
- impedance: 50 Ω (±10 %);
- frequency: selected mains frequency.

Generator for short duration disturbance

- waveform: sinusoidal, total harmonic distortion less than 10 %;
- open circuit output voltage range (r.m.s.): 10 V (–10 %) to 300 V (+10 %);
- impedance: 50 Ω (±10 %);
- frequency: selected mains frequency;
- on/off switching of the output voltage: synchronized at zero crossing (0° ± 5 %).

The schematic in principle of the test generator is given in figure 4.

6.1.3 Characteristics and performance of the generator for tests in the frequency range 15 Hz-150 kHz

The test generator typically consists of a waveform generator capable of covering the frequency band of interest. It shall have an automated sweep capability of 1×10^{-2} decade/s or slower or, in the case of a synthesizer, be capable of being programmed with frequency-dependent step-sizes of 10 % of the preceding frequency value. It shall also be capable of being set manually.

Specifications

- waveform: sinusoidal, total harmonic distortion less than 1 %;
- open circuit output voltage range (r.m.s.): 0,1 V (–10 %) to 30 V (+10 %);
- impedance: 50 Ω (±10 %);
- frequency range: 15 Hz (–10 %) to 150 kHz (+10 %).

6.2 Verification of the characteristics of the test generators

In order to make it possible to compare the results dealing with different test generators, they must be calibrated or verified for the most essential characteristics.

The following generator characteristics must be verified:

- output voltage waveform;
- generator impedance;
- frequency accuracy;
- open circuit output voltage accuracy;
- rise and fall time of the output voltage at on/off switching (where applicable).

The verifications shall be carried out with voltage probe and oscilloscope or other equivalent measurement instrumentation with 1 MHz minimum bandwidth.

The accuracy of the measuring equipment shall be better than ±5 %.

6.3 Coupling/decoupling networks

The coupling networks enable the test voltage to be applied, in common mode, to the power supply, input/output (signal and control) and communication ports of the EUT. The decoupling networks prevent the application of the test voltage to the auxiliary equipment needed to perform the test.

6.3.1 Coupling networks

6.3.1.1 Coupling network for power supply and input/output ports

For power supply and input/output ports, the coupling network for each conductor is composed of a resistor and a capacitor in series. The coupling networks of each conductor are connected in parallel to form the coupling network of the port.

Figure 6 shows a schematic circuit for a coupling network, the value of the capacitor is $C = 1{,}0\ \mu F$ and the resistor is $R = 100 \times n\ \Omega$ where n is the number of the conductors (n is greater than or equal to 2).

The capacitors and the resistors for each of the conductors in the coupling network for a port shall be matched with a tolerance of 1 %.

For the d.c. voltage test the 1,0 μF capacitors shall be short-circuited.

NOTE When performing the d.c. voltage test on a signal port, the impedance of the coupling network may cause the operating signal to be degraded.

For screened cables, the test signal is injected directly onto the cable shield, so no coupling network is required (see figure 6).

6.3.1.2 Coupling networks for communication port

For communication ports and other ports intended for connection to balanced pairs (single or multiple pairs), the coupling network is a T network.

Figure 5 shows a schematic circuit for a T network. The value of the capacitor is $C = 4{,}7\ \mu\text{F}$, the resistor is $R = 200\ \Omega$ and the inductor is $L = 2 \times 38$ mH (bifilar winding).

The components of the T network shall be matched with a tolerance such that the T network does not significantly degrade the common mode rejection ratio of the EUT.

NOTE It may be possible to produce T networks suitable for use with common mode rejection ratios greater than 80 dB, in which case the product standard should define an alternative coupling method.

6.3.2 Decoupling devices

6.3.2.1 General characteristics

The function of the decoupling device is to isolate the AE and/or simulator from the EUT port under test and thereby prevent the application of the test voltage to the AE and/or simulator.

The most important characteristic of a decoupling device is its common mode attenuation over the frequency range 0 Hz to 150 kHz.

Both active and passive isolation devices are available; examples of active devices include amplifiers and opto-isolators, whilst examples of passive devices include isolation transformers and translators.

6.3.2.2 Specifications

The isolation and decoupling specifications, applicable to all the devices for all the types of operating signals, are:

- input to output and input/output to ground insulation withstand capability: 1 kV, 50/60 Hz, 1 min;
- common mode decoupling (attenuation) in the range 15 Hz-150 kHz: 60 dB.

Decoupling devices with reduced insulation withstand capability may be used when testing at levels below level 4.

The common mode rejection of the decoupling device shall be as high as possible in order to minimize the degradation of the common mode rejection ratio of the EUT port.

The requirements of this subclause also apply to complex devices, such as a power supply unit composed by an isolation transformer and an a.c. to d.c. converter.

For balanced lines the T network specified in 6.3.1.2 provides effective decoupling into the frequency range 10 kHz to 150 kHz. A decoupling device is still required for frequencies below 10 kHz.

7 Test set-up

The test set-up specifications are given for

- earthing connections;
- equipment under test;
- test generator;
- coupling and decoupling network (decoupling/isolation devices).

7.1 Earthing connections

The safety earthing requirements of the EUT, of the auxiliary equipment (AE) and of the test equipment shall be complied with at all times.

The EUT shall be connected to the earthing system in accordance with the manufacturer's specifications. The test generator, the coupling networks and the decoupling devices shall be connected to a Ground Reference Plane (GRP) or to a common earth terminal. The earth connection to the GRP or to the common earth terminal shall be less than 1 m in length.

7.2 Equipment under test

The equipment under test shall be arranged and connected according to the equipment installation specifications.

The power supply, input/output and communication ports shall be connected to the sources of power supply, control and signals via the decoupling/isolation devices (see 6.3.2).

The operating signals for exercising the EUT may be provided by the auxiliary equipment or simulator.

The cables specified by the equipment manufacturer shall be used; in the absence of specifications, unshielded cables shall be adopted, of the type suitable for the signals involved.

The cable length is not relevant for the test, unless in the case of shielded cables (see 8.2). For shielded cables, where the manufacturer specifies a maximum cable length, this length shall be used; in all other cases, the cable length shall be 20 m.

7.3 Test generators

The test generator shall be connected to the coupling network or coupling resistor, as specified in clause 8.

7.4 Decoupling/isolation devices

The decoupling/isolation devices shall be connected between all the EUT's ports to be tested and the corresponding signal or power source.

Dedicated decoupling/isolation devices are not required if the AE or the power sources are isolated.

NOTE The decoupling/isolation devices should be located on the side of the cables near to the auxiliary equipment port, in order to use the normal terminations provided with the cables without the need to cut them.

In the case of shielded lines (e.g. coaxial cables), the generator shall be directly connected to the shields (no additional series resistor and capacitor are required).

8 Test procedure

The test procedure includes

- preliminary verification of the correct operation of the equipment.
- execution of the test.

8.1 Laboratory reference conditions

In order to minimize the impact of environmental parameters on test results, the tests shall be carried out in climatic and electromagnetic reference conditions as specified in 8.1.1 and 8.1.2.

8.1.1 Climatic conditions

Unless otherwise specified by the committee responsible for the generic or product standard, the climatic conditions in the laboratory shall be within any limits specified for the operation of the EUT and the test equipment by their respective manufacturers.

Tests shall not be performed if the relative humidity is so high as to cause condensation on the EUT or the test equipment.

NOTE Where it is considered that there is sufficient evidence to demonstrate that the effects of the phenomenon covered by this standard are influenced by climatic conditions, this should be brought to the attention of the committee responsible for this standard.

8.1.2 Electromagnetic conditions

The electromagnetic conditions of the laboratory shall not influence the test results.

8.2 Execution of the test

The EUT shall be configured for its normal operating conditions.

The tests shall be performed according to a test plan that shall specify

- type of test;
- test level;
- test duration;
- EUT's ports to be tested;
- representative operating conditions of the EUT;
- auxiliary equipment.

The power supply, signal and other functional electrical quantities shall be applied within their rated range. If the actual operating signal sources are not available, they may be simulated.

The main steps of the test procedure are as follows:

- preliminary verification of equipment performances;
- connection of the coupling networks and decoupling devices to the EUT's ports to be tested;
- verification of the operating performances of input signals, if necessary;
- application of the test voltage.

The test configuration can affect the operating conditions of the I/O ports of the EUT. These new conditions shall be considered as references in the evaluation of the test voltage influence.

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The test voltage shall be applied for a period of time sufficient to allow a complete verification of the EUT's operating performance. For short duration tests (of typically 1 s duration), the test voltage shall be applied repeatedly until this criterion has been met.

The test in the frequency range 15 Hz-150 kHz starts from 15 Hz; the rate of sweep shall not exceed 1×10^{-2} decade/s. Where the frequency is swept incrementally, the step size shall not exceed 10 % of the start and thereafter 10 % of the preceding frequency value.

The performance of the EUT shall be continuously monitored, and any degradation shall be recorded in the test report.

The test generator shall be connected to each port in turn. Ports not under test shall have the input terminals of their respective coupling network connected to ground (see figure 6).

If the apparatus has a large number of similar ports, then a sufficient number shall be selected so that all different types of termination are covered.

NOTE A preliminary investigation should be carried out applying the test voltage to the earth port of the EUT in the complete set-up described for type tests. Susceptibility conditions, if any, will be investigated on a port-by-port basis.

The ports provided by unshielded cables shall be tested by applying the test voltage directly to the port's terminals.

In the case of shielded lines (e.g. coaxial cables), the generator output shall be directly connected to the screen (no additional series resistor and capacitor are required).

To test ports with more than two terminals (e.g. grouping), the test voltage shall be applied simultaneously between all the terminals of the port and ground (common mode).

For ports intended to be connected to balanced lines, the test voltage shall be applied using the T network specified in 6.3.1.2.

During the test with application of d.c. voltage, the polarity of the test voltage shall be reversed.

A general schematic for the application of the test voltage is given in figure 6.

The test voltage shall be applied in common mode to the following ports:

- power supply;
- input and output;
- communication.

The performances of the EUT shall be verified against the requirements of the plan.

The test can produce unsafe situations due to the test voltage involved or the leakage current to earth: adequate safety precautions are essential to avoid risks to operators.

9 Evaluation of test results

The test results shall be classified in terms of the loss of function or degradation of performance of the equipment under test, relative to a performance level defined by its manufacturer or the requestor of the test, or agreed between the manufacturer and the purchaser of the product. The recommended classification is as follows:

a) normal performance within limits specified by the manufacturer, requestor or purchaser;

b) temporary loss of function or degradation of performance which ceases after the disturbance ceases, and from which the equipment under test recovers its normal performance, without operator intervention;

c) temporary loss of function or degradation of performance, the correction of which requires operator intervention;

d) loss of function or degradation of performance which is not recoverable, owing to damage to hardware or software, or loss of data.

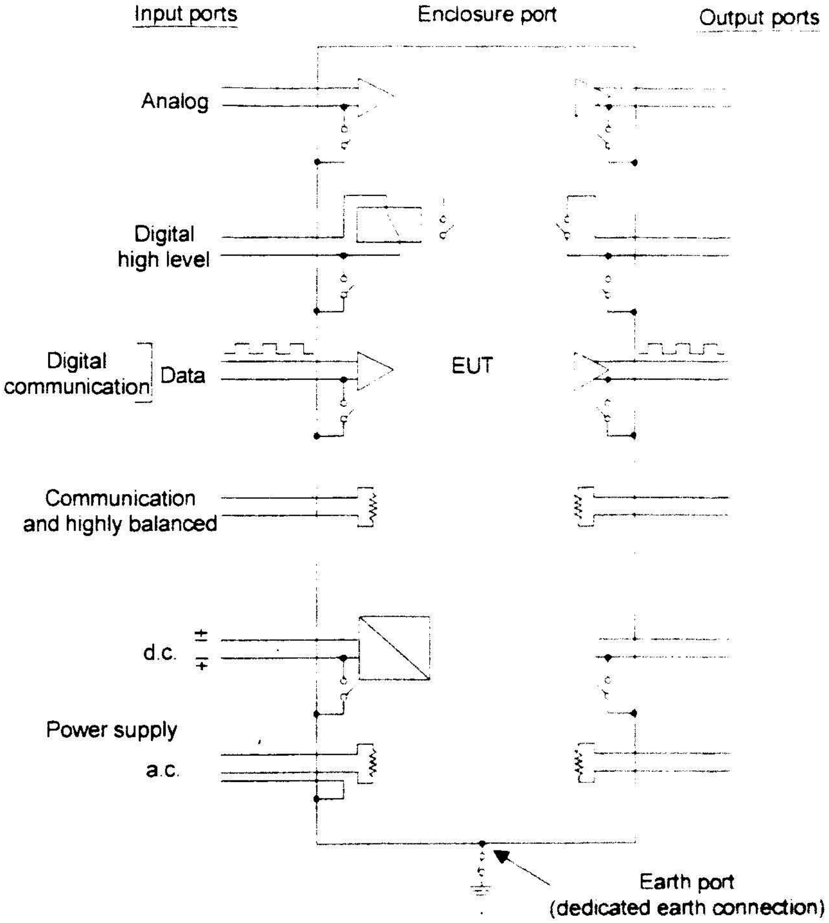
The manufacturer's specification may define effects on the EUT which may be considered insignificant, and therefore acceptable.

This classification may be used as a guide in formulating performance criteria, by committees responsible for generic, product and product-family standards, or as a framework for the agreement on performance criteria between the manufacturer and the purchaser, for example where no suitable generic, product or product-family standard exists.

10 Test report

The test report shall contain all the information necessary to reproduce the test. In particular, the following shall be recorded:

- the items specified in the test plan required by clause 8 of this standard;
- identification of the EUT and any associated equipment, for example, brand name, product type, serial number;
- identification of the test equipment, for example, brand name, product type, serial number;
- any special environmental conditions in which the test was performed, for example, shielded enclosure;
- any specific conditions necessary to enable the test to be performed;
- performance level defined by the manufacturer, requestor or purchaser;
- performance criterion specified in the generic, product or product-family standard;
- any effects on the EUT observed during or after the application of the test disturbance, and the duration for which these effects persist;
- the rationale for the pass/fail decision (based on the performance criterion specified in the generic, product or product-family standard, or agreed between the manufacturer and the purchaser);
- any specific conditions of use, for example cable length or type, shielding or grounding, or EUT operating conditions, which are required to achieve compliance.



NOTE The switch position is related to the possible configuration of the ports: single-ended, isolated, etc

Figure 1 – Example of equipment ports and configuration

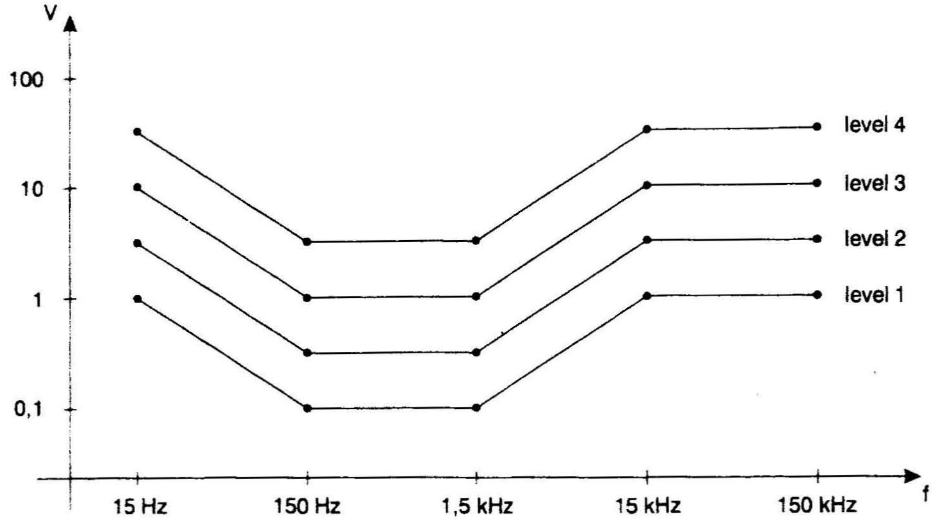
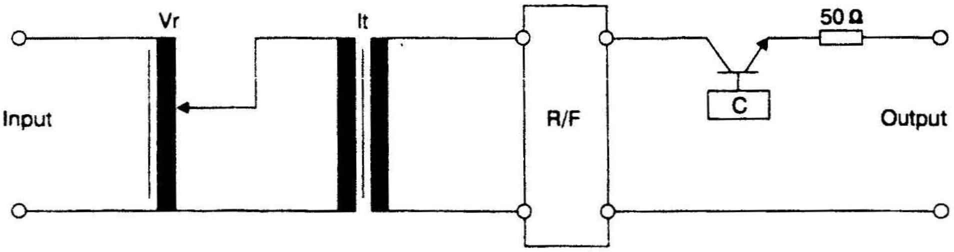
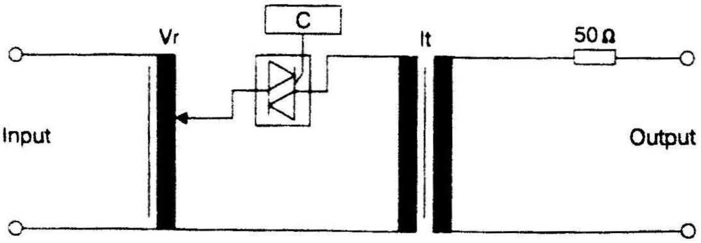


Figure 2 – Profile of the test voltage



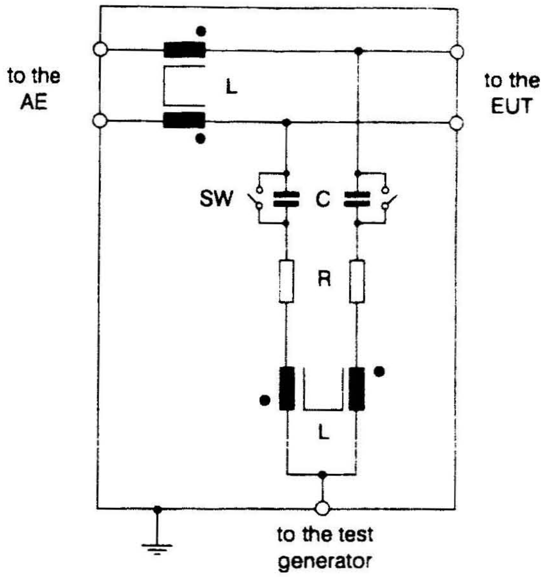
Vr: voltage regulation
It: isolation transformer
R/F: rectification/filtering
C control circuit

Figure 3 – Schematic in principle of the generator for d.c. voltage tests



Vr: voltage regulation
C: control circuit
It: isolation transformer

Figure 4 – Schematic in principle of the generator for tests at mains frequency ($16^{2/3}$ Hz, 50 Hz and 60 Hz)

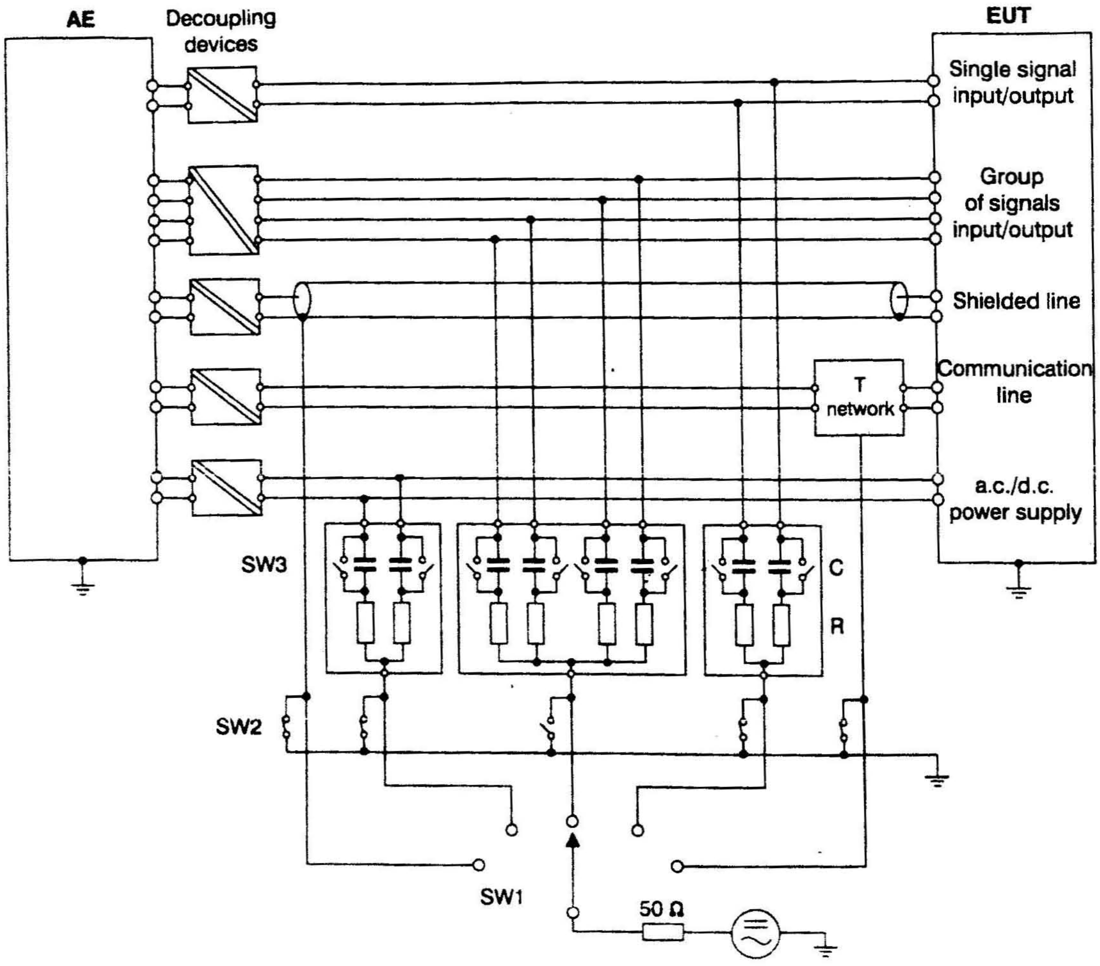


R: 200 Ω

C: 4,7 μF, to be short-circuited for d.c. voltage test (SW)

L: 2 × 38 mH (bifilar winding)

Figure 5 – Schematic circuit of the coupling T network for communication ports and other ports intended for connection to highly balanced pairs



C = 1,0 µF, to be short-circuited for d.c. voltage test (SW3)

R = 100 Ω × n conductors belonging to the port concerned

Example for n = 4: R = 400 Ω

NOTE Switch SW2 is used to connect all input terminals to ground, other than under test (see 8.2).

Figure 6 – Schematic circuit for type tests

Annex A
(informative)

Sources of disturbances and coupling mechanisms

A.1 Sources of disturbances

The conducted, common mode disturbances at mains frequency and its harmonics may be generated by faults on the mains power distribution system and leakage currents flowing into the earth system.

The d.c. power supply network used in industrial, electrical plants and telecommunication centres may also generate d.c. common mode disturbances, particularly when either the positive or negative terminal is connected to earth.

Electrified railways will also generate disturbances at their frequency of operation (typically $16\frac{2}{3}$ Hz)

The induced disturbances are described in detail in IEC 61000-2-3 and IEC 61000-2-5. The different types of disturbances may be present simultaneously but at different levels. Furthermore, if the power system develops a fault, the disturbance levels may be up to 10 times the reference levels given for normal operating conditions, however the fault condition disturbances are typically present for short durations only (up to about 1 s).

The disturbances at mains frequency and harmonics may affect signal ports of equipment where insufficient common mode rejection is available.

Disturbances up to 1-2 kHz are mainly due to the harmonics of the power mains.

At higher frequencies the disturbances are mostly related to power electronic equipment, which may produce switching currents involving the ground system, giving rise to conducted, common mode disturbances.

A.2 Coupling mechanisms

The coupling mechanisms considered in this clause include the capacitive, inductive and resistive coupling. Details on the different coupling mechanisms are reported in IEC 61000-2-3. Capacitive coupling is not relevant where the signal lines have a reference to ground, e.g. due to a termination to earth or to the presence of capacitive filters.

Inductive coupling, due to the magnetic fields generated by the source of disturbances (e.g. power line, ground circuits), often produces significant disturbances in signal cables.

Resistive (or common impedance) coupling can directly affect signal lines, as in the case of earthed signal source, or can inject current into the shield of a signal cable. This type of coupling can appear the most relevant and sometimes may be considered inclusive of the effects of capacitive and inductive coupling.

The equivalent impedance of the coupling mechanisms may have a wide range of values, depending on layout of the victim and of the source.

In the worst case of common impedance coupling, the equivalent coupling impedance may have values in the order of few ohms. In other cases the impedance may present values higher by several orders of magnitude, as in the case of balanced lines subjected to capacitive coupling.

Experience in laboratory has shown that the immunity tests on the different ports of the equipment can be efficiently performed with a single representative source impedance having the value of 150 Ω. This value may also represent the common mode characteristic impedance of a power or signal line in the field, and is in accordance with the approach adopted by other basic standards in the IEC 61000-4 series.

Annex B
(informative)

Selection of test levels

This standard describes different tests. The applicability of each test, the test level and the related acceptance criteria shall be defined in the product standards.

The test levels should be selected in accordance with the most realistic installation and environmental conditions.

A guideline for the applicability of the tests and the selection of the levels for various installations is given in IEC 61000-2-5. The latter gives a range of disturbance levels for different locations.

Based on common installation practices, the following practical rules may be used to classify the environment:

Level 1: Well protected environment

The installation is characterized by the following attributes:

- separation of the internal power supply network from the mains network, e.g. by dedicated isolation transformers;
- electronic equipment earthed to a dedicated earthing collector, connected to the earthing system (ground network) of the installation.

A computer room may be representative of this environment.

Level 2: Protected environment

The installation is characterized by the following attributes:

- direct connection to the low voltage mains network;
- electronic equipment earthed to the earthing system of the installation.

Control room or terminal room located in a dedicated building of industrial plants and power plants may be representative of this environment.

Level 3: Typical industrial environment

The installation is characterized by the following attributes:

- direct connection to the low voltage or medium voltage mains network;
- electronic equipment earthed to the earthing system of the installation (ground network);
- use of power convertors injecting stray currents into the ground network.

Industrial installations and power plants may be representative of this environment.

Level 4: Severe industrial environment

The installation is characterized by the following attributes:

- direct connection to the low voltage or medium voltage mains network;
- electronic equipment connected to the earthing system of the installation (ground network) common to HV equipment and systems;
- use of power convertors injecting stray currents into the ground network.

GIS and open-air HV substations, and the related power plant, may be representative of this environment.

Level 5: Special situations, to be analyzed

Special installation conditions may be analyzed or investigated, and consequently immunity requirements higher or lower than specified for the different class may be defined.

Annex C
(informative)

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1) To be published

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